Hydrologic Analysis Using Interactive Modeling

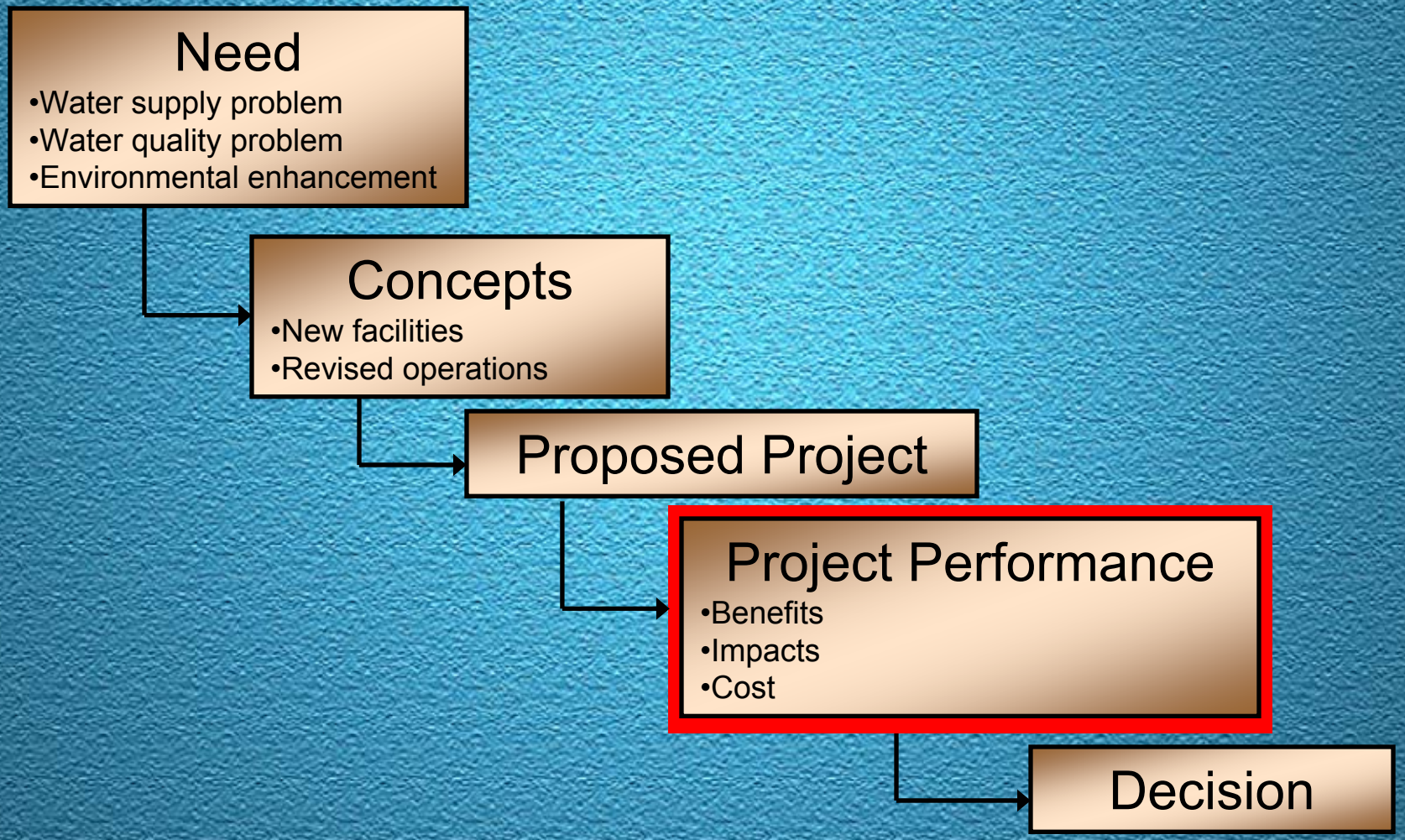
May 24, 2004

MBK ENGINEERS

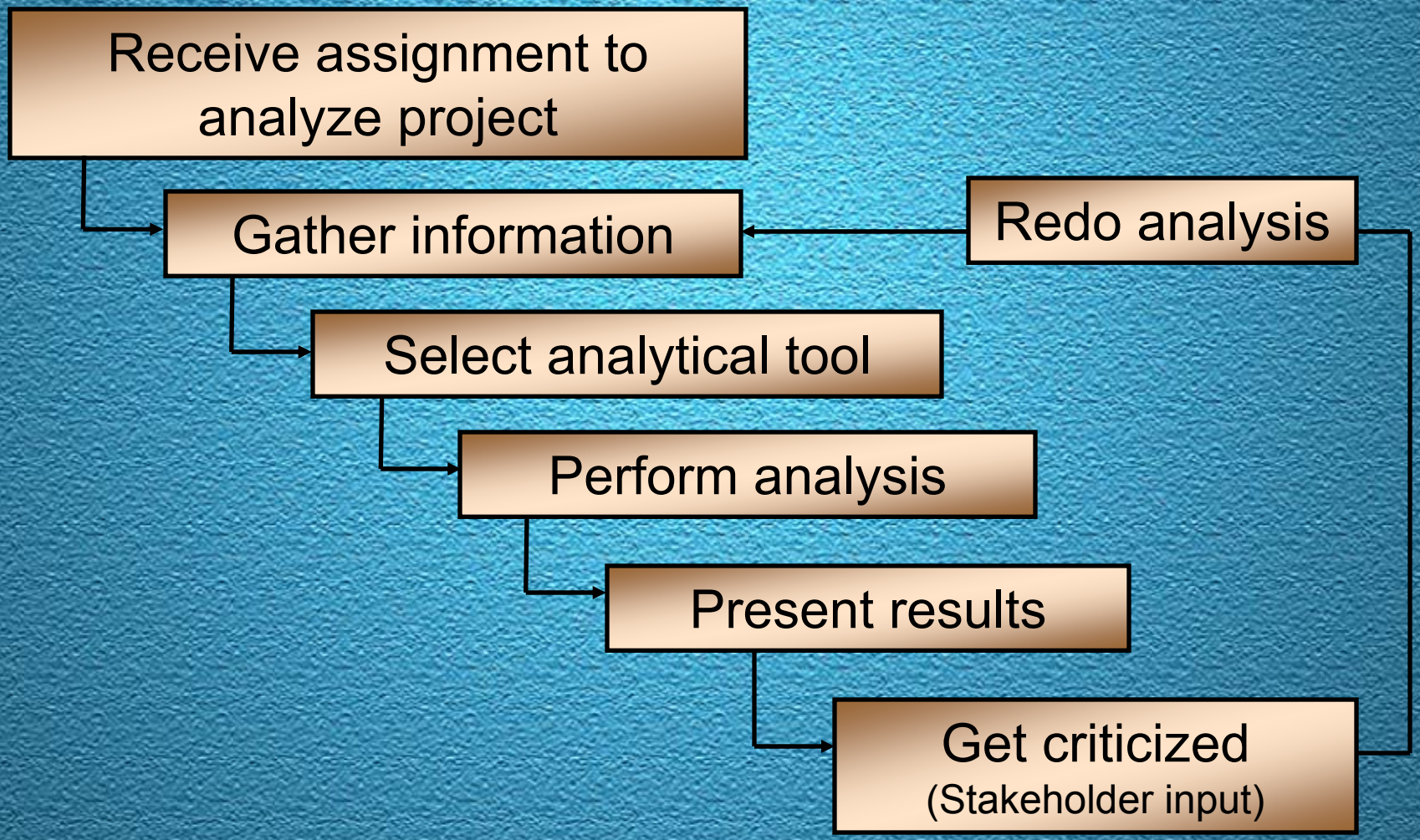
Outline

- Use of interactive modeling in hydrologic analysis
- Examples
  - Sacramento Basin
  - San Joaquin River Restoration Project
  - Madera ID
  - Marin MWD
  - Exchanges

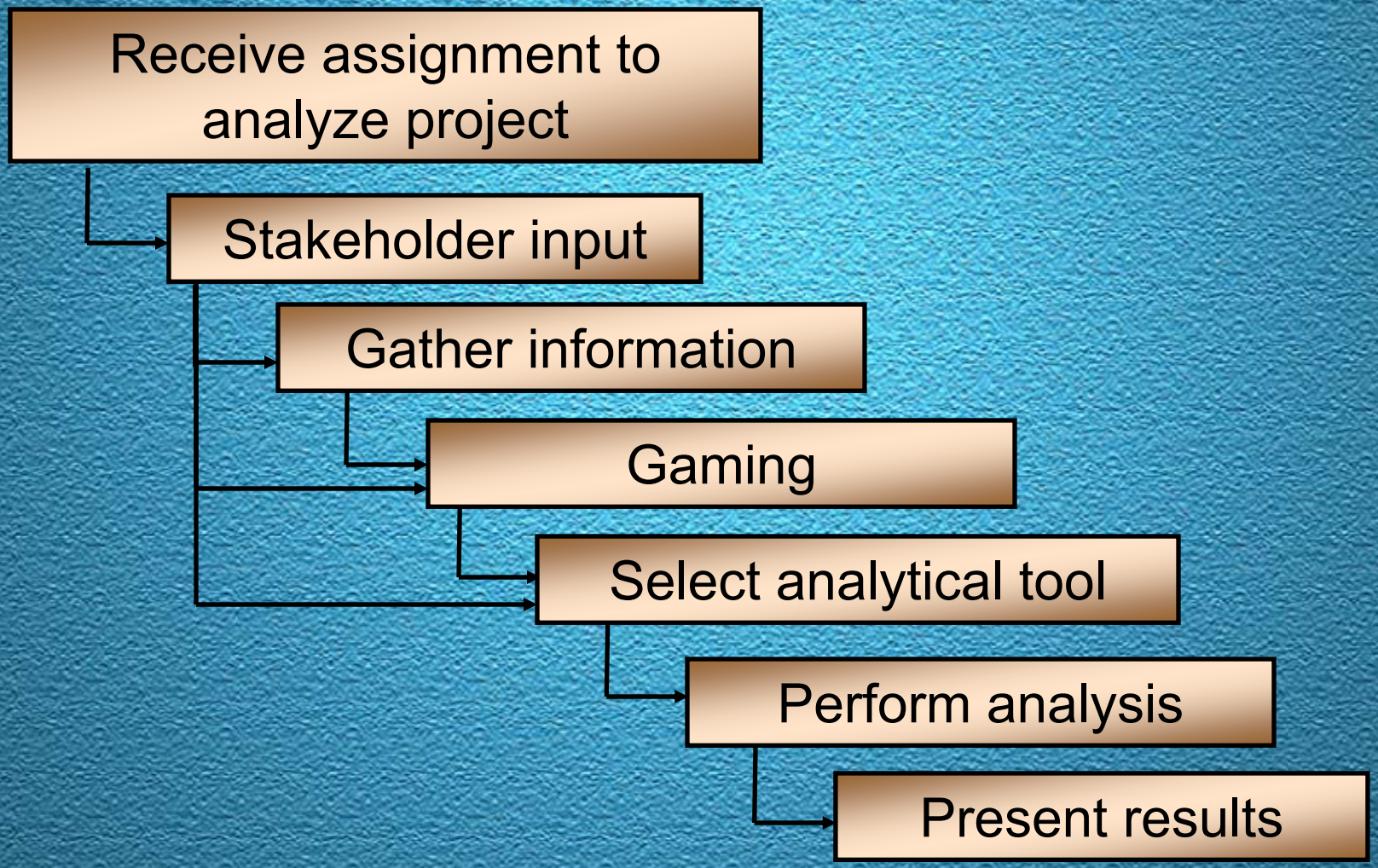
Purpose for Analysis
(why perform the analysis?)



Common Analyst's Approach



Analyst's Approach Using Gaming




Managers and Policy Makers
System Operators
Water Users
Environmental Resources
Gaming
Operate system
Engineers
Outcome
Develop Common Understanding of Issues
Develop Analytical Strategy
Scope and Scale of Potential Benefits

Steps To Gaming

- Establish Objectives
  - Agree on objectives and modeling rules
  - Define geographic scope
  - Define alternatives
  - Define performance measures
- Participation of Experts
  - Ground gaming to reality
- Build Gaming Tools
  - Determine type of interactive model(s) required
  - Input from technical experts is essential
  - Establish baseline
- Perform Gaming
- Document Document Document

Benefits of Gaming

- Develop common understanding of:
  - Water system and issues
  - Alternatives
  - Scope and scale of potential benefits from alternatives
- Take complex water system and make it easy for most to understand
- Stakeholders are “locked” in room for long periods discussing project
- Stakeholders are more involved upfront
  - Increase in stakeholder confidence in analysis
  - Stakeholders have better understanding of analysis and how to interpret results
- Minimal effort in explaining results

Nature of Gaming

- It is only a Game!
- Operational guidelines for facilities do not necessarily reflect the best use of facilities
- Many of the physical characteristics of the system are ignored (the system is simplified)
- Operational strategies may not be applied in a consistent manner throughout the game

Examples

- Sacramento Basin
- Sites Reservoir
- San Joaquin River Restoration Project
- Madera ID
- Marin MWD
- Exchanges

Sacramento Basin Gaming - Fall 2000
Basin Wide Management Plan

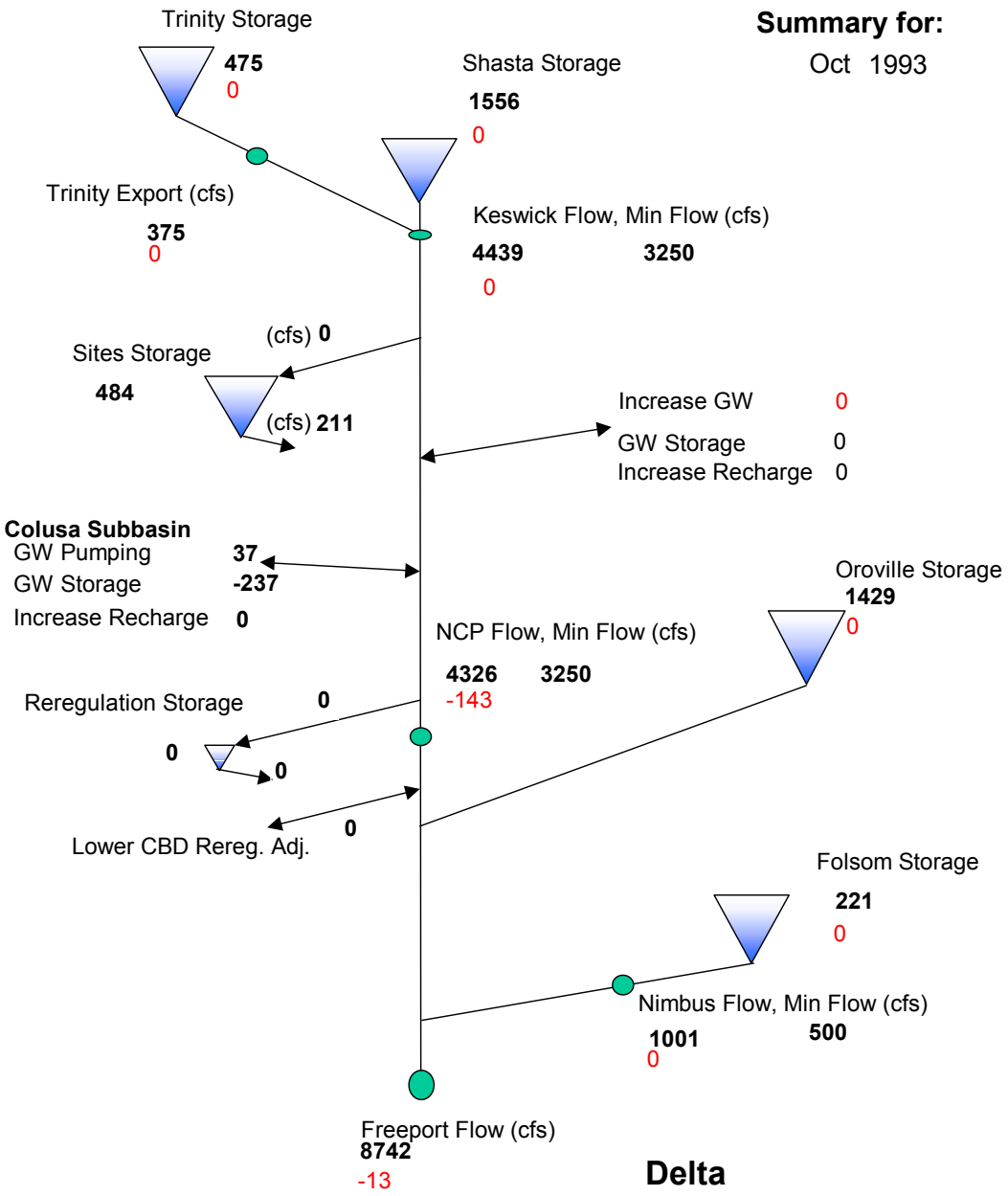
Goals:

To identify opportunities to:

- Improve reliability of deliveries to Sacramento Basin users
- Increase benefits to environment
  - Provide Refuge water supplies
  - Reduce diversions during periods critical to fish
  - Increase instream fishery flows
  - Enhance Delta flows and water quality
- Satisfy unmet demands in Sacramento Basin
- Increase south of Delta exports

Geographic Area

- Covers operation and hydrology of entire CVP/SWP system
- Existing facilities operated in game
  - Trinity, Shasta, Oroville, Folsom, and groundwater
- Includes:
  - Sacramento, American, and Feather Rivers
  - Delta is considered using EWA gaming model


Summary for:
Oct 1993
Trinity Storage
475
0
Shasta Storage
1556
0
Trinity Export (cfs)
375
0
Keswick Flow, Min Flow (cfs)
4439
3250
0
(cfs) 0
Sites Storage
484
(cfs) 211
Increase GW 0
GW Storage 0
Increase Recharge 0
Colusa Subbasin
GW Pumping 37
GW Storage -237
Increase Recharge 0
Oroville Storage
1429
0
NCP Flow, Min Flow (cfs)
4326
3250
-143
Reregulation Storage 0
0
0
0
Lower CBD Rereg. Adj.
Folsom Storage
221
0
Nimbus Flow, Min Flow (cfs)
1001
500
0
Freeport Flow (cfs)
8742
-13
Delta
CVP Export (cfs) 2837
SWP Export (cfs) 2837
Freeport Surplus 0
Increase Export (cfs) 0
Units in TAF Unless Noted
Red: Indicates Change From Initial Conditions
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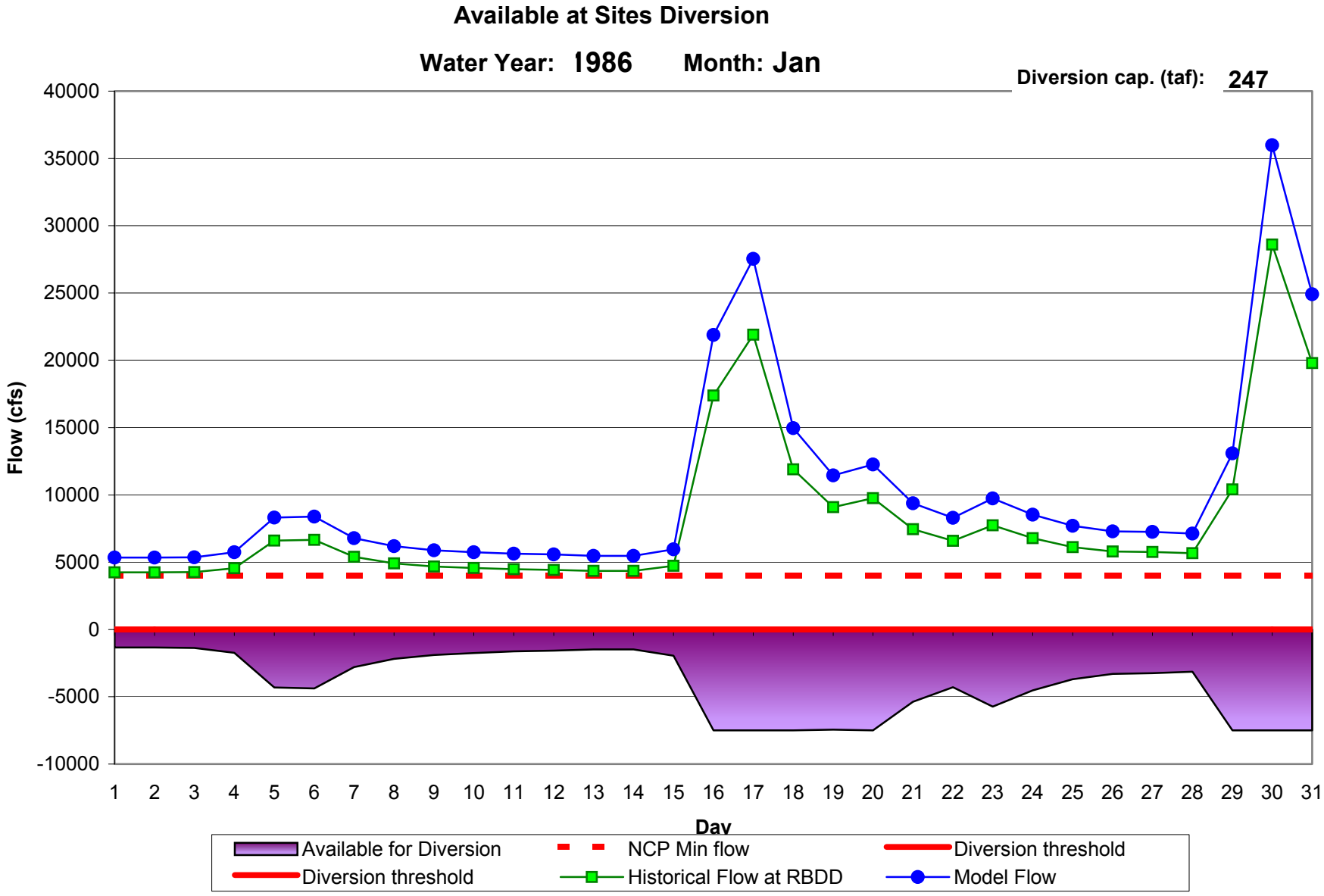
3 Gaming Sessions
(Fall 2000)

- Game 1 - Existing Facilities
  - Reoperate system for additional benefit
  - Increase GW pumping to reduce river diversions
- Game 2 - New Facilities
  - Enlarged Shasta Lake (300 taf)
  - Expanded Ground Water (100 taf in-lieu, increase recharge)
  - Re-regulatory Storage (30 and 40 taf in Colusa Sub-basin)
  - Increased Banks Export Capacity (8,500 cfs)
- Game 3 – Additional New Facilities
  - Enlarged Shasta Lake (300 taf)
  - Expanded Ground Water (200 taf in-lieu, increase recharge)
  - Increased Banks Export Capacity (10,300 cfs)
  - Sites Reservoir (1.9 maf, existing plus new 5000 cfs diversion cap., Sac. flow requirement for geomorphology)

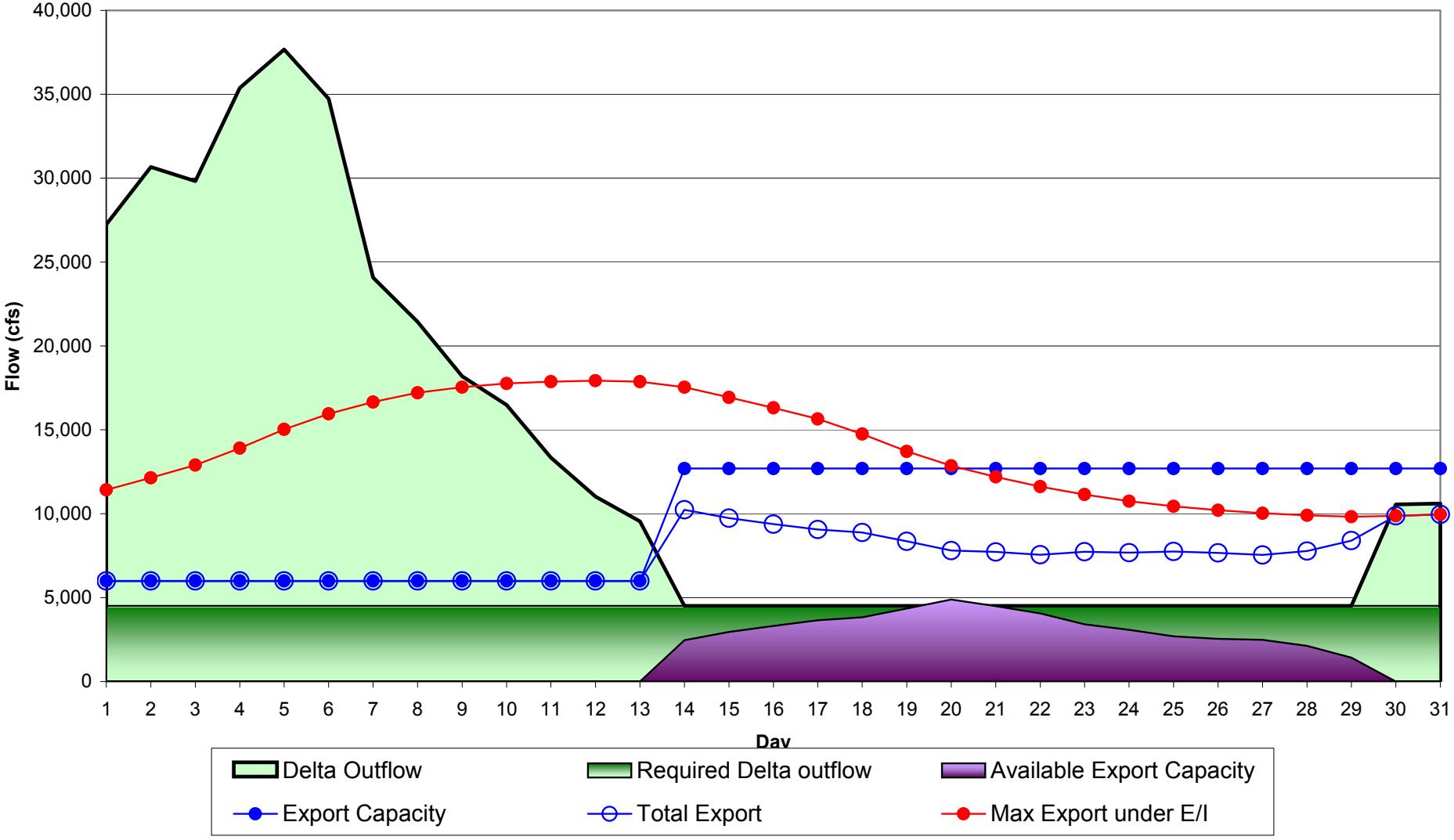
Sacramento Basin Gaming for Sites Reservoir (October 10-11, 2001)

- Focus:
  - Operation for Sites Reservoir
    - Including Conjunctive Use
  - Assumptions for Sites is similar to earlier game
- Greater involvement from fishery agencies than earlier Sacramento Basin Gaming


Available at Sites Diversion
Water Year: 1986
Month: Jan
Diversion cap. (taf): 247
Flow (cfs)
40000
35000
30000
25000
20000
15000
10000
5000
0
-5000
-10000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
Day
Available for Diversion
NCP Min flow
Diversion threshold
Diversion threshold
Historical Flow at RBDD
Model Flow

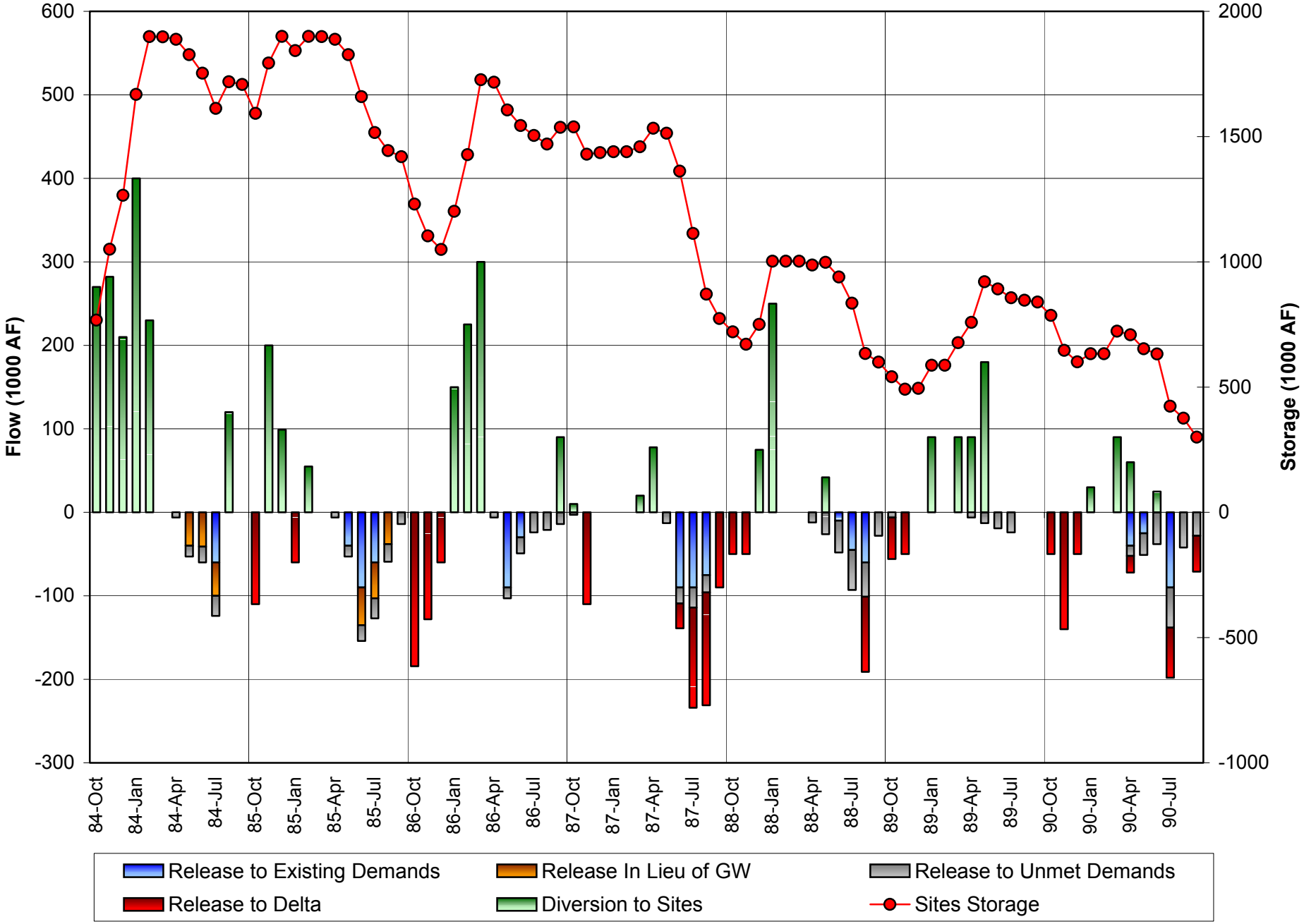
Water Year: 1986 Month: 3

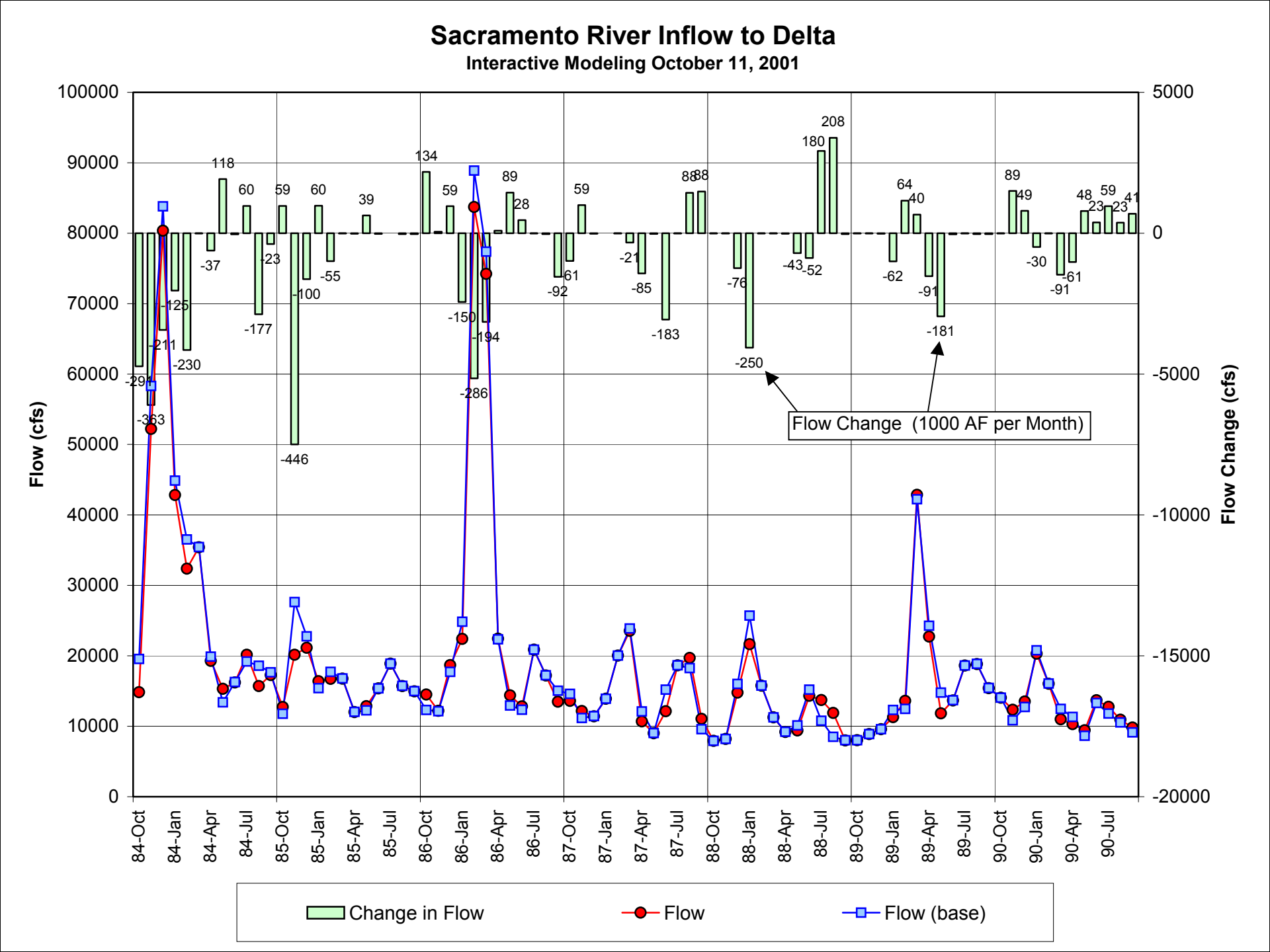
Delta Summary

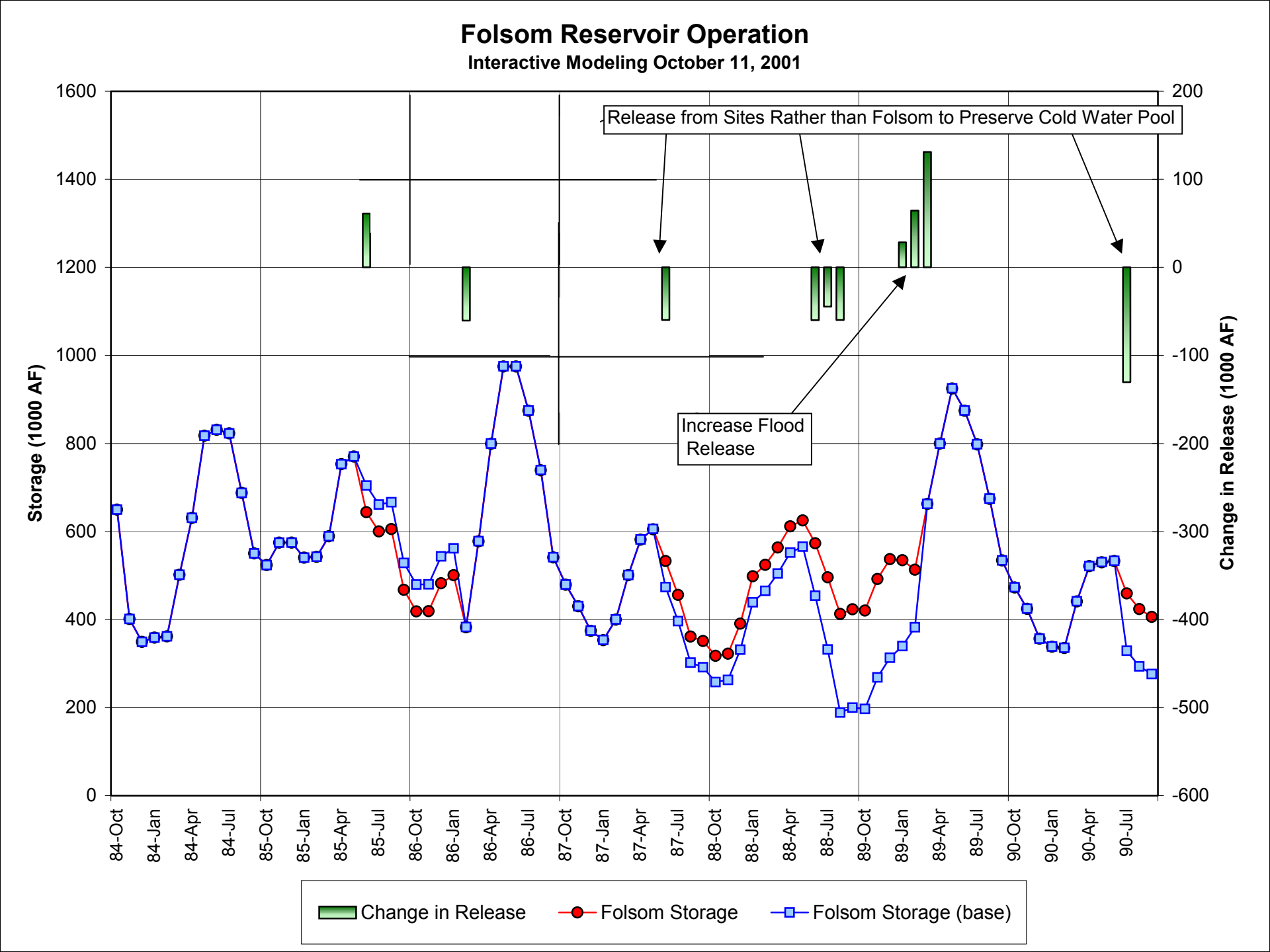


Sites Reservoir Operation

Interactive Modeling October 11, 2001




Sacramento River Inflow to Delta
Interactive Modeling October 11, 2001
Flow (cfs)
Flow Change (cfs)
Flow Change (1000 AF per Month)
Change in Flow
Flow
Flow (base)
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
5000
0
-5000
-10000
-15000
-20000
84-Oct
84-Jan
84-Apr
84-Jul
85-Oct
85-Jan
85-Apr
85-Jul
86-Oct
86-Jan
86-Apr
86-Jul
87-Oct
87-Jan
87-Apr
87-Jul
88-Oct
88-Jan
88-Apr
88-Jul
89-Oct
89-Jan
89-Apr
89-Jul
90-Oct
90-Jan
90-Apr
90-Jul
-294
-363
-211
-125
-230
-37
118
60
-177
59
-23
-446
-100
60
-55
39
134
59
-150
-286
-194
89
28
-92
-61
59
-21
-85
-183
88
88
-76
-250
-43
-52
180
208
-62
64
40
-91
-181
89
49
-30
-91
-61
48
23
59
23
41

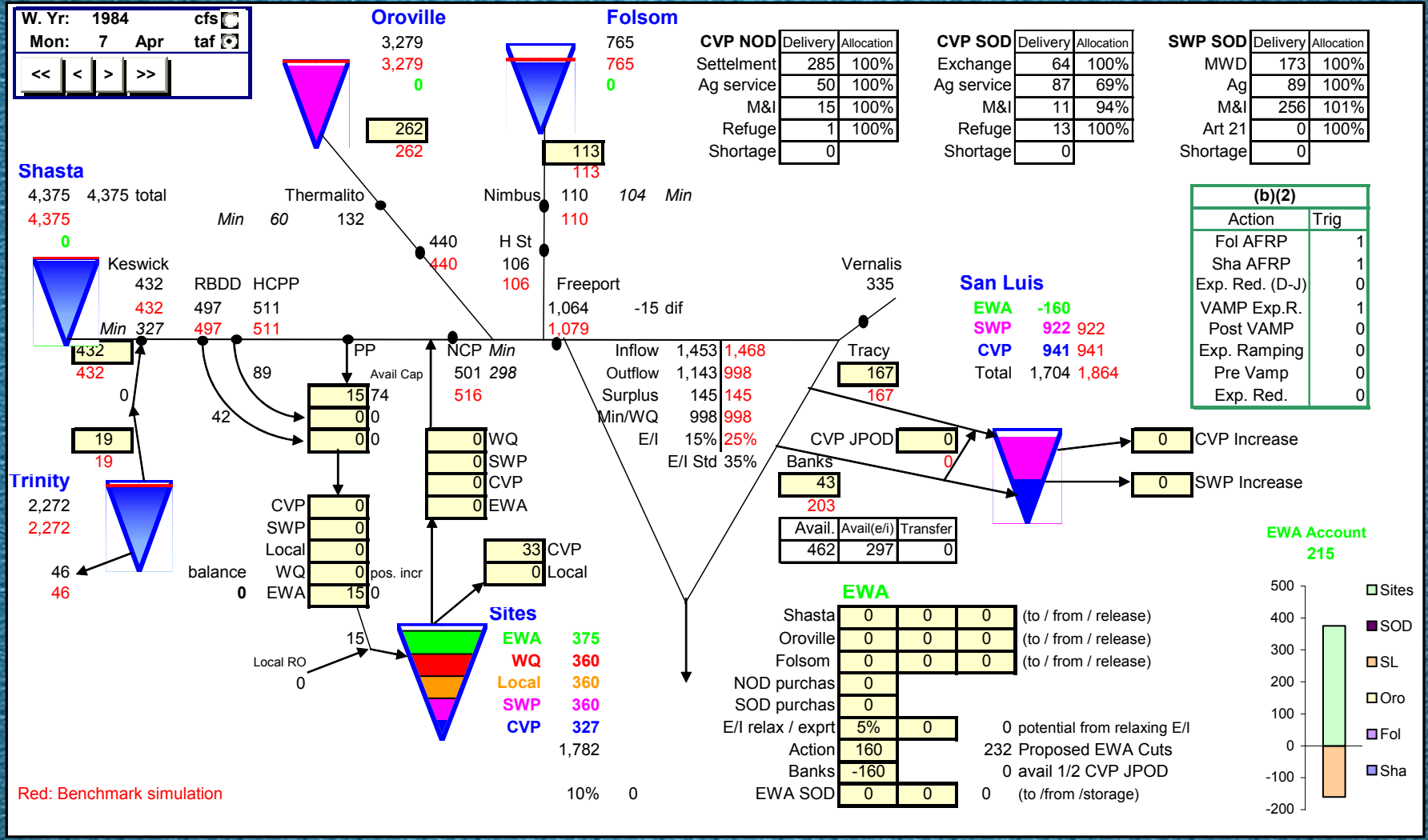

Folsom Reservoir Operation
Interactive Modeling October 11, 2001
Release from Sites Rather than Folsom to Preserve Cold Water Pool
Increase Flood Release
Storage (1000 AF)
Change in Release (1000 AF)
1600
1400
1200
1000
800
600
400
200
0
200
100
0
-100
-200
-300
-400
-500
-600
84-Oct
84-Jan
84-Apr
84-Jul
85-Oct
85-Jan
85-Apr
85-Jul
86-Oct
86-Jan
86-Apr
86-Jul
87-Oct
87-Jan
87-Apr
87-Jul
88-Oct
88-Jan
88-Apr
88-Jul
89-Oct
89-Jan
89-Apr
89-Jul
90-Oct
90-Jan
90-Apr
90-Jul
Change in Release
Folsom Storage
Folsom Storage (base)

Gaming Sites Reservoir
June 2003

Goal:

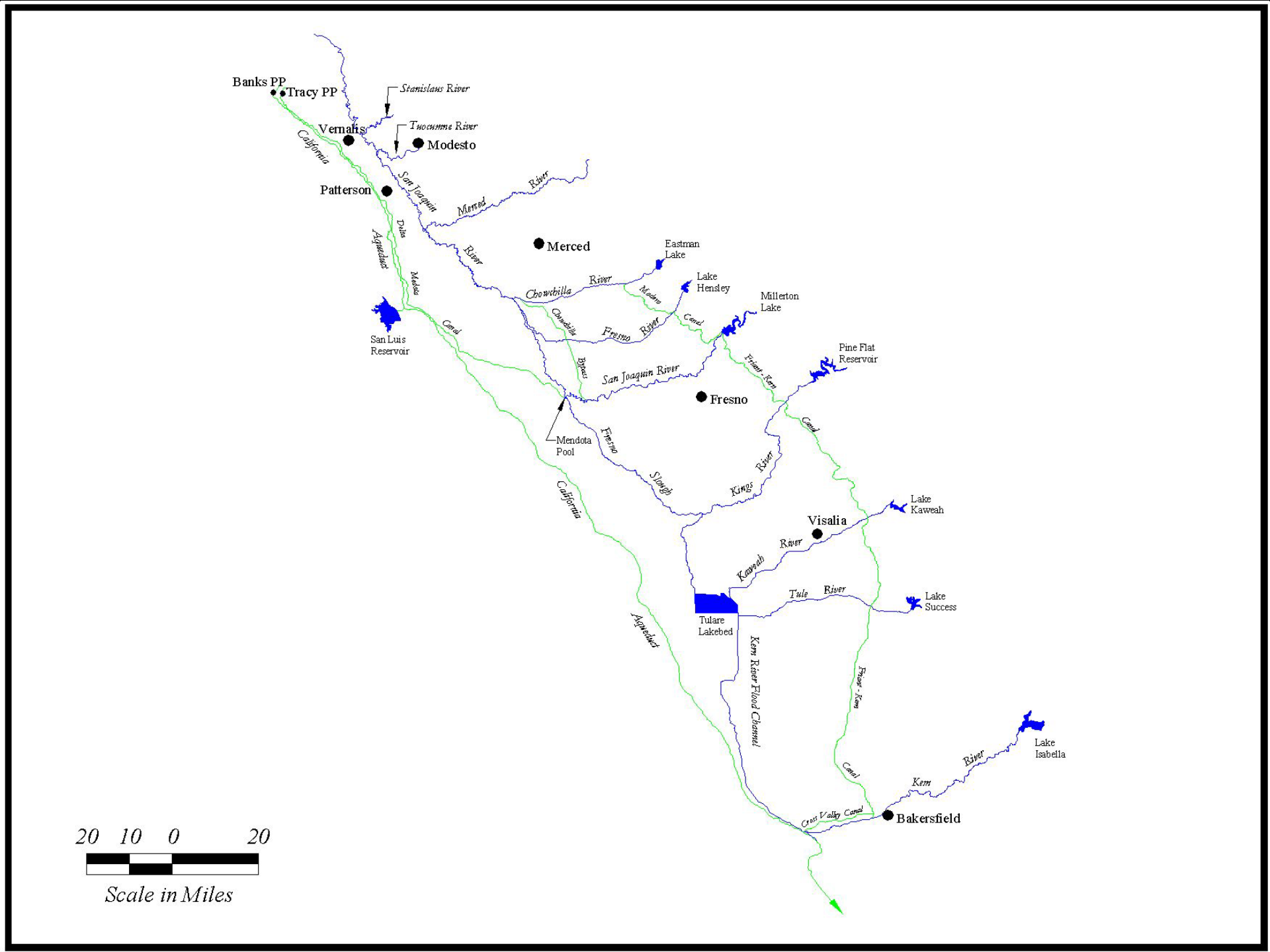
- Operate EWA portion of Sites Reservoir
  - Gain insight on EWA benefits from Sites Reservoir to aid in analysis using CALSIM

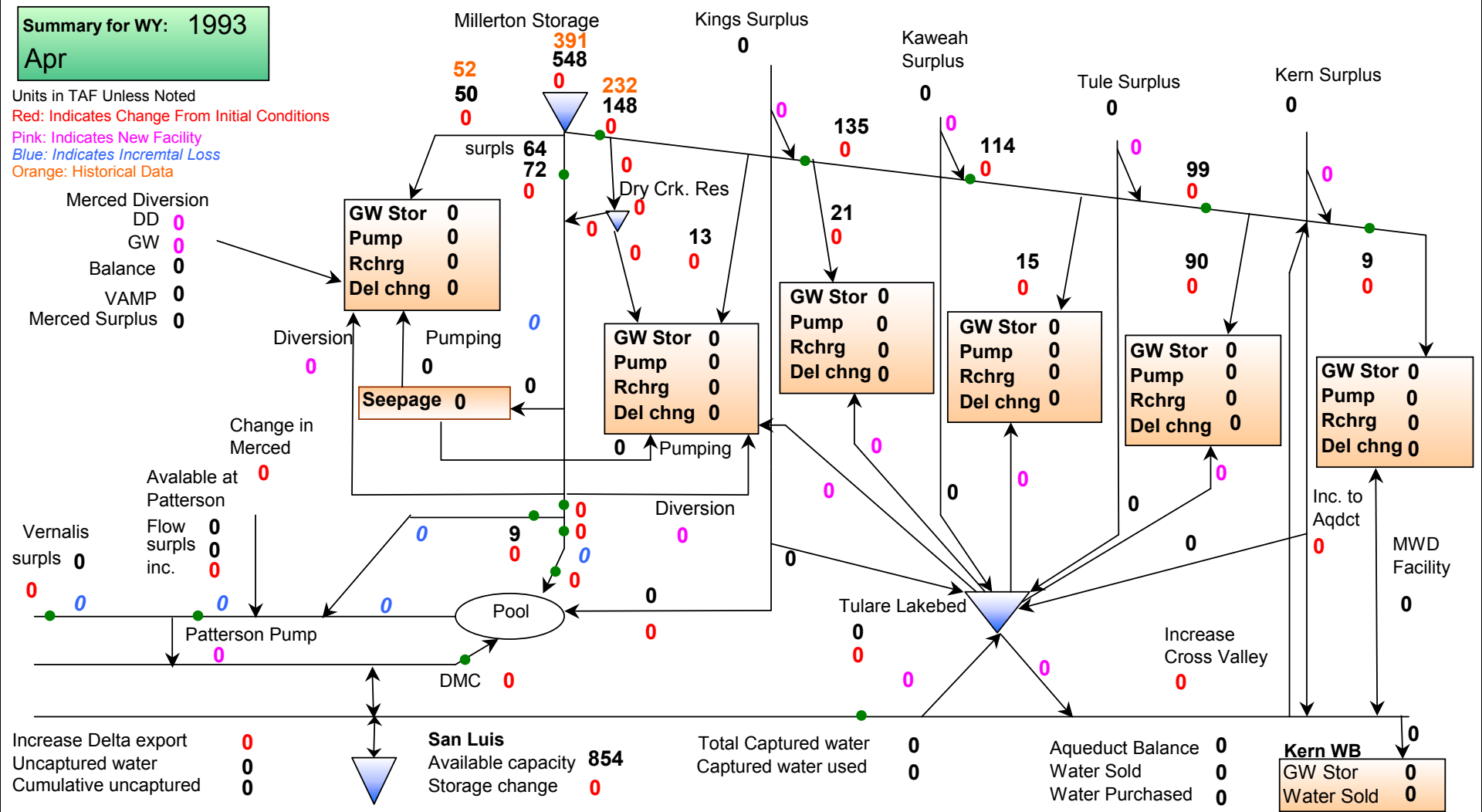
Model Schematic



San Joaquin River Restoration Project (FWUA – NRDC) Example

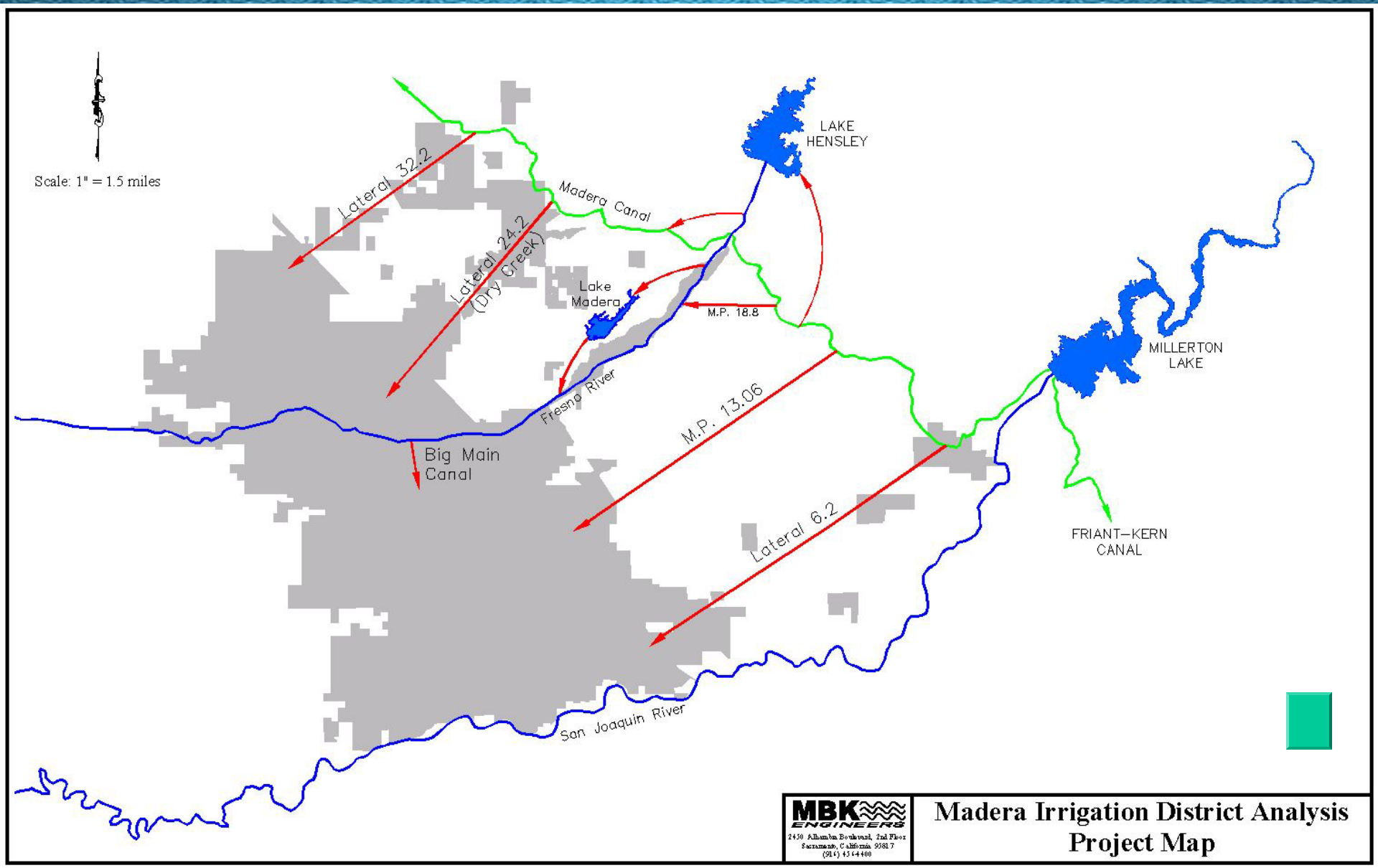
- Project Objective
  - Provide flow to San Joaquin River below Friant Dam while maintaining water deliveries
- Purpose of gaming in accomplishing project objective
  - Education – Develop common understanding
  - Learn about alternatives and potential operations
  - Help define functionality of simulation model
  - Help define assumptions in simulations


Banks PP
Tracy PP
Stanislaus River
Tuocumne River
Vernalis
Modesto
California
Aqueduct
San Joaquin
River
Patterson
Delta
Mendota
Canal
Merced
River
Merced
Eastman
Lake
Lake
Hensley
Chowchilla
River
Madera
Canal
Millerton
Lake
Chowchilla
Bypass
Fresno
River
San Luis
Reservoir
San Joaquin River
Friant-Kern
Canal
Pine Flat
Reservoir
Fresno
Mendota
Pool
Fresno
Slough
Kings
River
California
Aqueduct
Lake
Kaweah
Visalia
Kaweah
River
Tule
River
Lake
Success
Tulare
Lakebed
Kern River Flood Channel
Friant - Kern
Canal
Lake
Isabella
Kern
River
Cross Valley Canal
Bakersfield
20 10 0 20
Scale in Miles

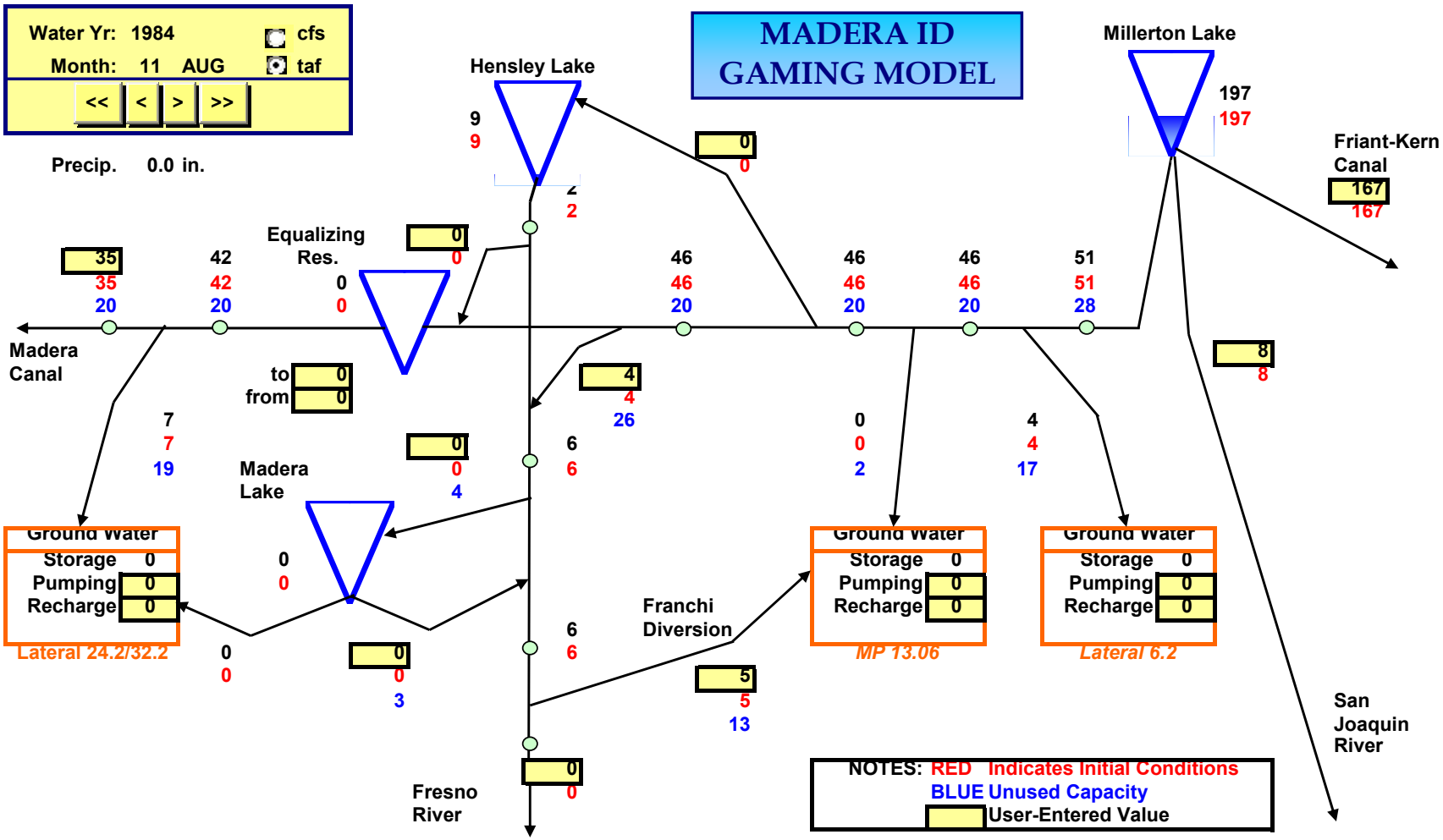

Summary for WY: 1993
Apr
Units in TAF Unless Noted
Red: Indicates Change From Initial Conditions
Pink: Indicates New Facility
Blue: Indicates Incremtal Loss
Orange: Historical Data
Millerton Storage
391
548
52
50
0
232
148
surpls 64
72
Kings Surplus
Kaweah Surplus
Tule Surplus
Kern Surplus
135
114
99
Dry Crk. Res
21
13
15
90
9
Merced Diversion
DD 0
GW 0
Balance 0
VAMP 0
Merced Surplus 0
GW Stor 0
Pump 0
Rchrg 0
Del chng 0
Diversion
Pumping
Seepage 0
Change in Merced
Avalable at Patterson
Flow surpls inc.
Vernalis surpls
Pool
Patterson Pump
DMC
Tulare Lakebed
Increase Cross Valley
Inc. to Aqdct
MWD Facility
Increase Delta export
Uncaptured water
Cumulative uncaptured
San Luis
Available capacity 854
Storage change
Total Captured water
Captured water used
Aqueduct Balance
Water Sold
Water Purchased
Kern WB
GW Stor
Water Sold

Madera ID Example

- Specific to single district
- Focus:
  - Stabilize ground water Levels
  - Expanded conjunctive use
  - Possible enlargement of regulatory reservoirs
  - Reoperation of existing facilities


Scale: 1" = 1.5 miles
Lateral 32.2
Madera Canal
Lateral 24.2
(Dry Creek)
LAKE
HENSLEY
Lake
Madera
M.P. 18.8
MILLERTON
LAKE
Fresno River
M.P. 13.06
Big Main
Canal
Lateral 6.2
FRIANT–KERN
CANAL
San Joaquin River
MBK
ENGINEERS
2450 Alhambra Boulevard, 2nd Floor
Sacramento, California 95817
(916) 456-4400
Madera Irrigation District Analysis
Project Map

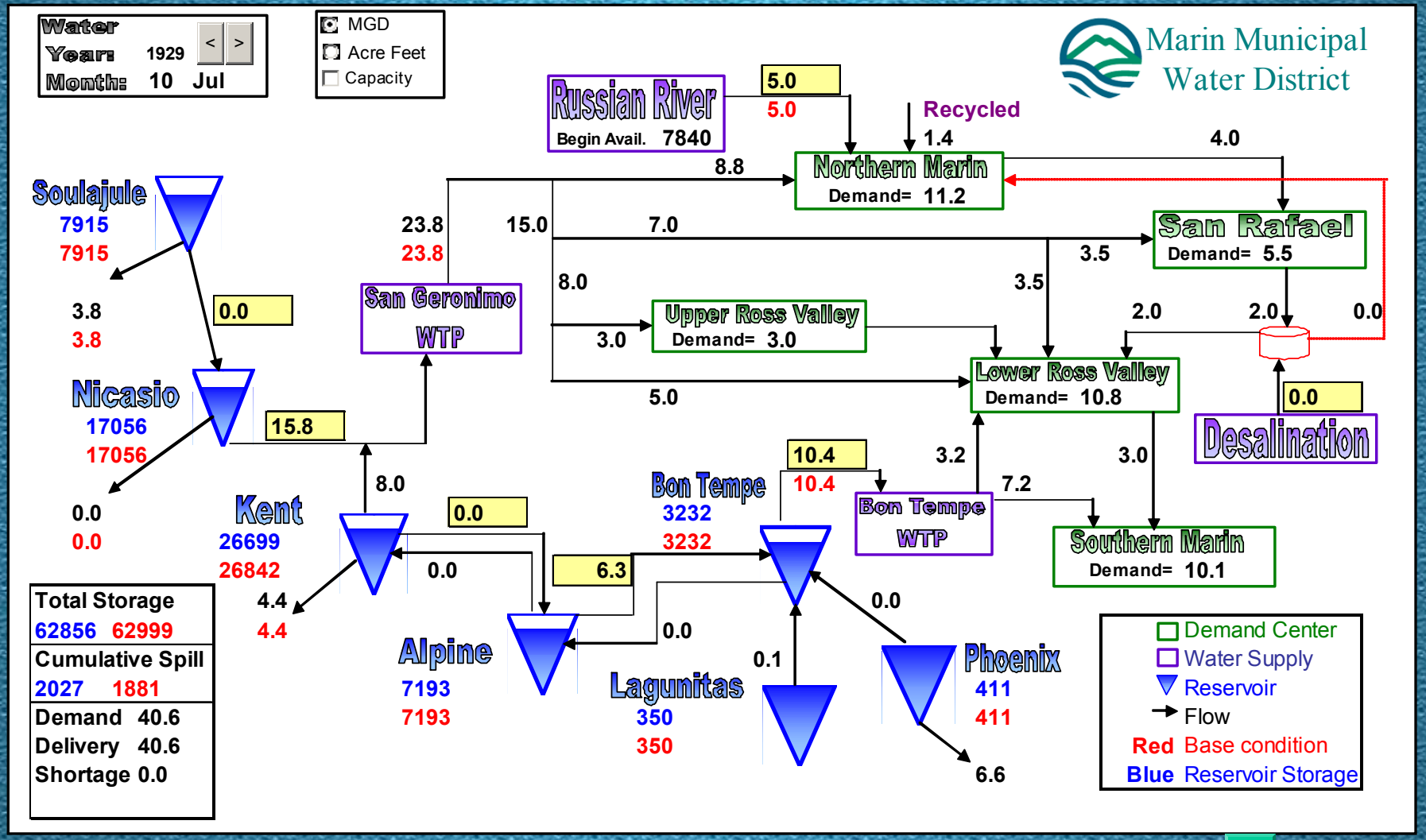
Model Schematic



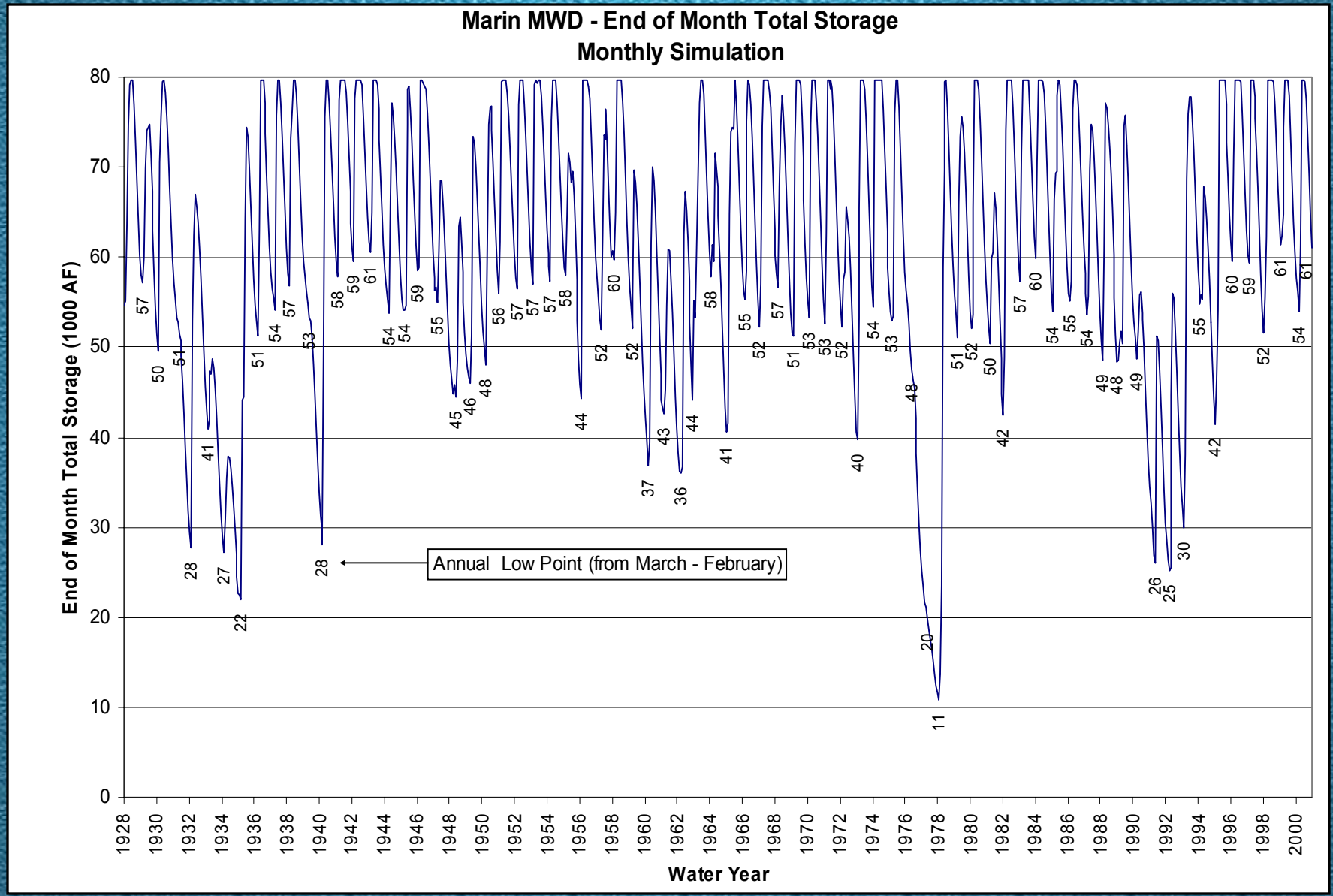
Marin MWD Example

- Specific a municipal water district
- Focus:
  - Integration of new supply
    - Expanded supply pipeline
    - Desalination plant
  - Reoperation of existing facilities
- Performed game by:
  - Stepping through monthly operation
  - Simulating through 73 year hydrologic sequence

Model Schematic



Sample Simulation Results



KRWA / MWD
Fall 2002 - Spring 2003

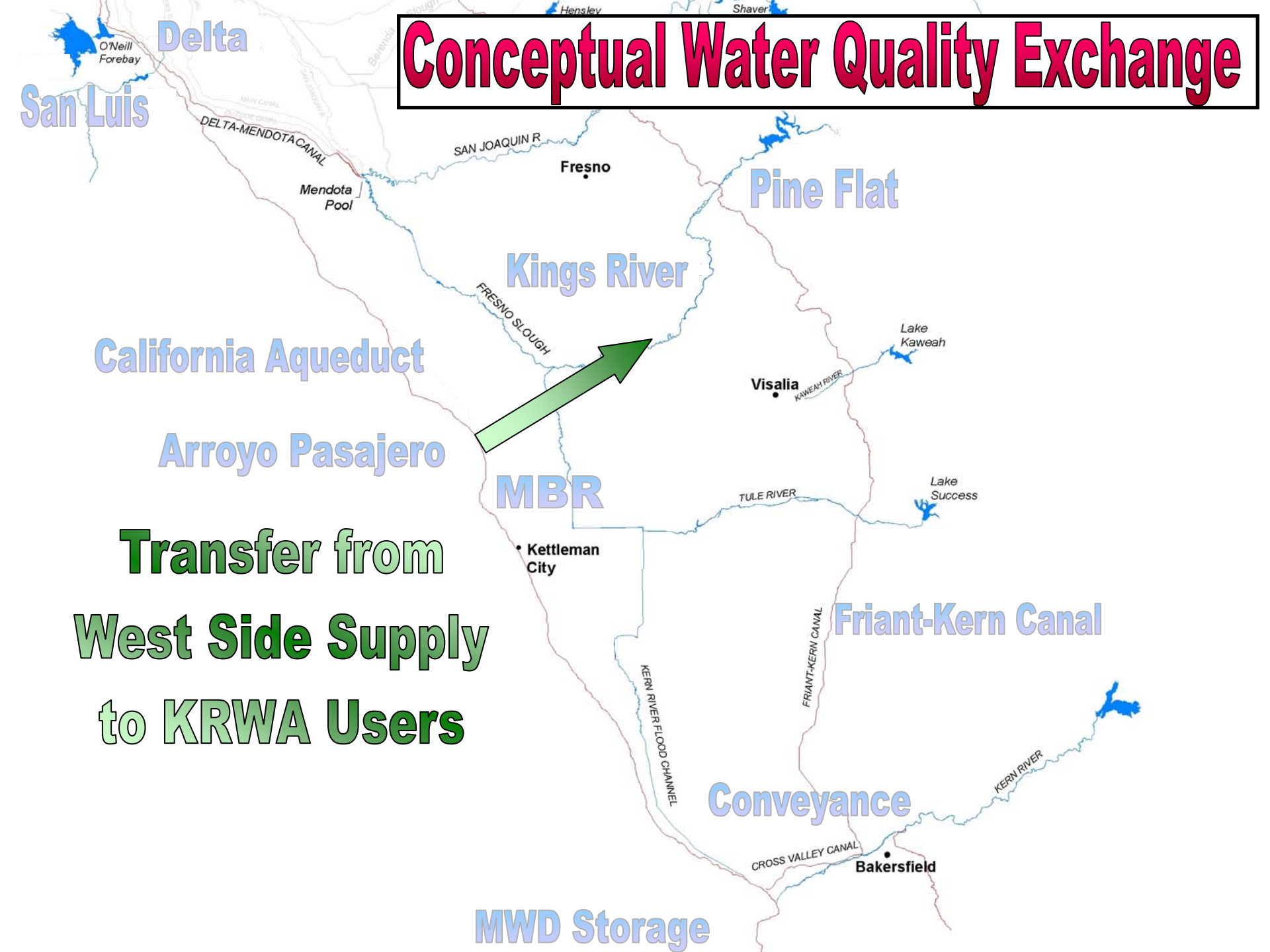
Department of Water Resources

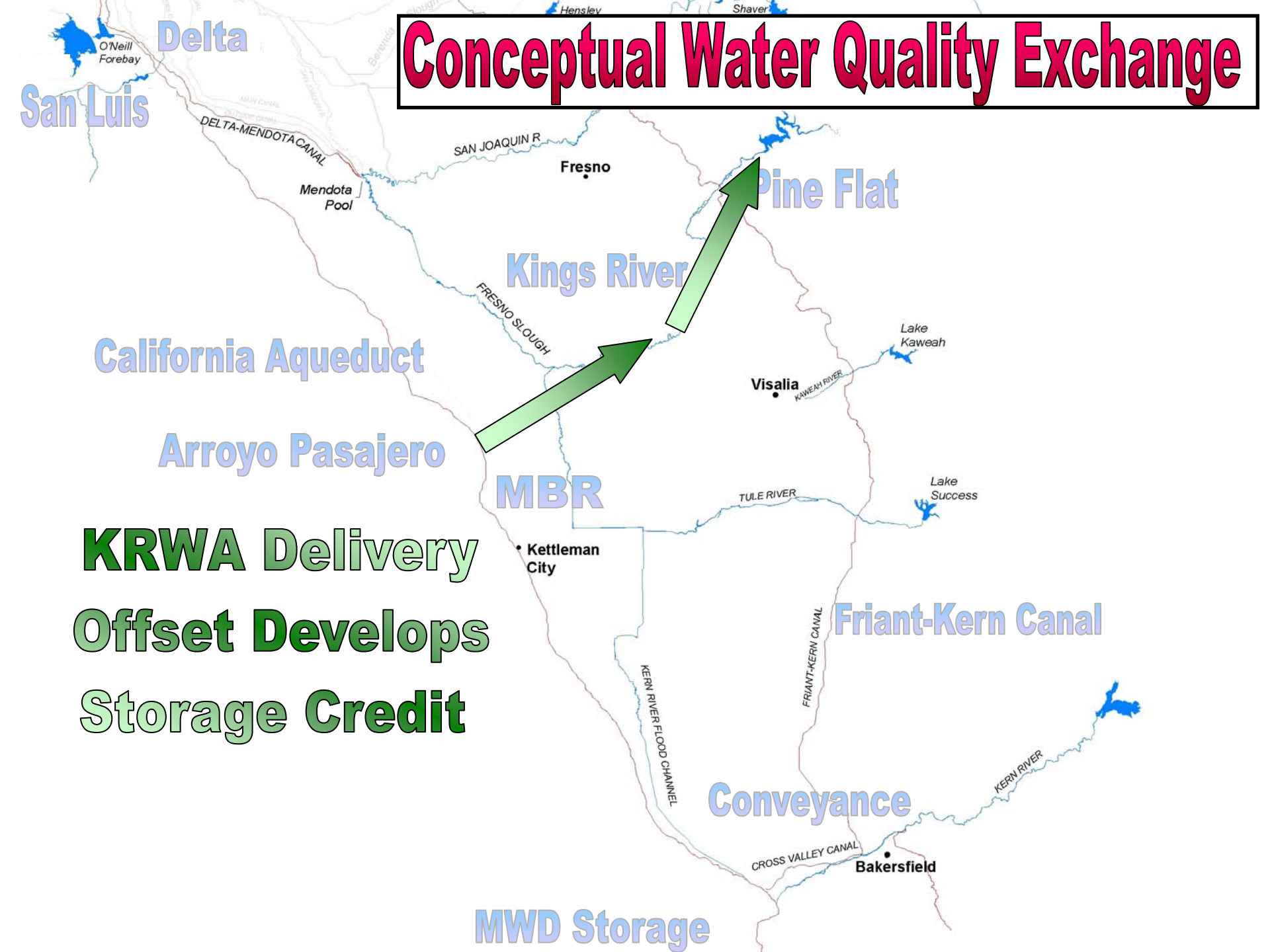
EWA

Arroyo Pasajero

Kings River Water Association

Metropolitan Water District of So. CA


Conceptual Water Quality Exchange
Delta
San Luis
O'Neill Forebay
DELTA-MENDOTA CANAL
SAN JOAQUIN R
Fresno
Mendota Pool
Pine Flat
Kings River
FRESNO SLOUGH
California Aqueduct
Lake Kaweah
Visalia
KAWEAH RIVER
Arroyo Pasajero
MBR
TULE RIVER
Lake Success
Kettleman City
Transfer from
West Side Supply
to KRWA Users
Friant-Kern Canal
FRIANT-KERN CANAL
KERN RIVER FLOOD CHANNEL
KERN RIVER
Conveyance
CROSS VALLEY CANAL
Bakersfield
MWD Storage


Conceptual Water Quality Exchange
Delta
San Luis
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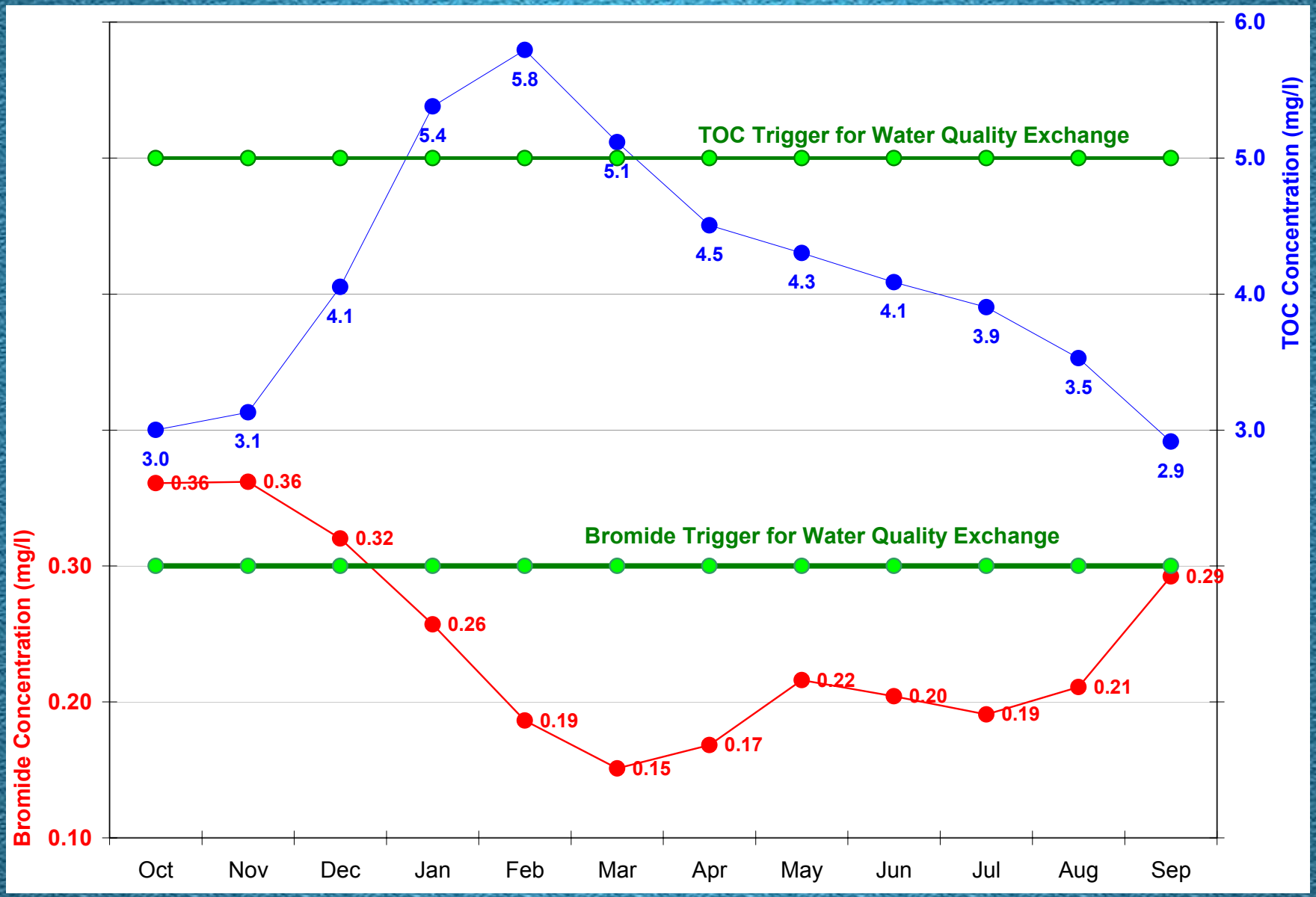
Mendota Pool
Pine Flat
Kings River
FRESNO SLOUGH
California Aqueduct
Lake Kaweah
Visalia
KAWEAH RIVER
Arroyo Pasajero
MBR
TULE RIVER
Lake Success
KRWA Delivery
Offset Develops
Storage Credit
Kettleman City
Friant-Kern Canal
FRIANT-KERN CANAL
KERN RIVER FLOOD CHANNEL
Conveyance
KERN RIVER
CROSS VALLEY CANAL
Bakersfield
MWD Storage

Conceptual Water Quality Exchange

Water Released to Friant-Kern Canal Conveyed to CA

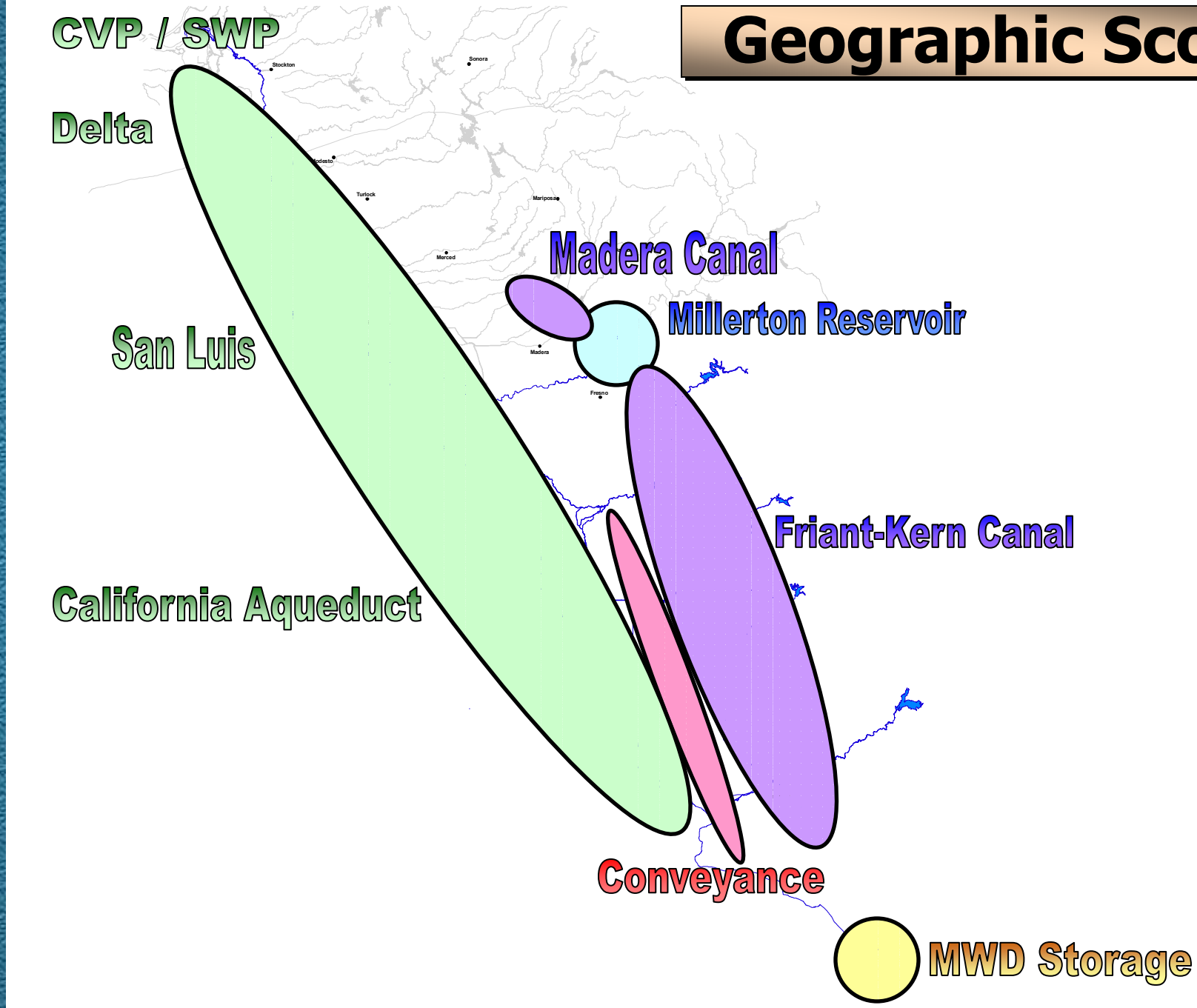
Sample
Average Monthly Water Quality in California Aqueduct at Edmonston



Friant Water Users / MWD
Spring - Summer 2004

- Status: Just starting – first session in June
- Goal:
  - Water supply reliability
  - Water quality benefits

Geographic Scope



Conclusions

Gaming is Not Gambling


Managers and Policy Makers
System Operators
Water Users
Environmental Resources
Gaming
Operate system
Engineers
Outcome
Develop Common Understanding of Issues
Develop Analytical Strategy
Scope and Scale of Potential Benefits

Benefits of Gaming

- Education – Develop common understanding
- Better define problems to be solved
- Better define alternatives
- Aid in developing analysis
- Input from range of stakeholders
- Saves time
- Builds confidence
- Argue about issues rather than model